Feedbacks Between Bottom Roughness, Bioturbation Intensity and Epibenthic Microalgae

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LONG-TERM GOALS

The ultimate objective of this research program is to identify and obtain a predictive understanding of the physical and biological processes responsible for the formation and maintenance of the microtopography (decimeter to millimeter) of the sea floor. To achieve this goal, it is necessary to study formative processes occurring on the sediment surface (e.g., biogenic mound formation, ripple development), as well as processes occurring within the seabed (e.g., bioturbation, compaction) which generally lessen microtopography. The approach to this area of interest is predominantly field-oriented, with a secondary emphasis on model development.

OBJECTIVES

The objective of this project, which is part of the Coastal Benthic Optical Properties (**CoBOP**) DRI, is to study the impact of bottom roughness (biological and physical), bioturbation and near-surface porosity on benthic optical properties. Field studies at a sediment sites offshore of Lee Stocking Island, Bahamas are continuing. Focus during this biennium is on elucidating the mechanisms leading to the observed patterns of roughness and near-surface porosity.

APPROACH

Measurements of bottom roughness are made using a 35-mm PhotoSea 2000 metric stereocamera mounted on a neutrally-buoyant, diver-manipulatable vehicle (“survey”) or using a similar stereocamera mounted on a tripod (“time-lapse”). Following standard film development, the images are digitized at a high resolution (i.e., > 4000 ppi) by a third-party aerial mapping firm and stored on CD-ROMs. Sea floor height information is obtained from analytically rectified (epipolar transformation) digital stereo-images using matching algorithms.

Independent, co-located measurements of sediment bioturbation intensity and mode are made during the field studies. The bioturbation measurements involve the spreading of glass beads onto a patch of sea floor, followed by tube coring and vertical sectioning after periods of days to months. Tracers are enumerated by dissolving the ambient carbonate grains.

Near-bed flow information is collected during the time-lapse deployments using a Sontek ADV.

Measurements of near surface porosity are made using an in situ resistivity profiler (IRP).

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14. ABSTRACT

The ultimate objective of this research program is to identify and obtain a predictive understanding of the physical and biological processes responsible for the formation and maintenance of the microtopography (decimeter to millimeter) of the sea floor. To achieve this goal, it is necessary to study formative processes occurring on the sediment surface (e.g., biogenic mound formation, ripple development), as well as processes occurring within the seabed (e.g., bioturbation, compaction) which generally lessen microtopography. The approach to this area of interest is predominantly field-oriented, with a secondary emphasis on model development.

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WORK COMPLETED

Field activities during FY 01 were limited to a brief visit to Lee Stocking Island in April 2001, during which measurements were made of near-surface porosity using the IRP. These activities were highly successful.

Laboratory analyses during the year have focused on generation of accurate digital elevation models (DEMs) for the time-lapse and survey stereophotographs and the statistical characterization of the DEMs. In addition, measurements of down core tracer distributions were made and IRP and Sontek ADV data were processed and shared with other CoBOP PIs (e.g. Allison, Boss, Burdige, Voss).

RESULTS

Significant results were obtained in two areas of research. First, measurements using the IRP indicate there is a consistent difference in the near-surface (i.e., upper 10-mm) porosity of sediment covered with micro-algal mats vs. bare sediment (Wheatcroft, submitted; Decho et al., submitted). Typically, differences are on the order of 0.1 higher in the mats (Figure 1), and this zone of higher porosity corresponds to a region of enhanced light penetration (Decho et al., submitted).

Second, the survey digital elevation model data clearly indicate differences between the roughness near vs. far from the North Perry reef (Fig. 2). In particular, height spectra for the far-reef seafloor exhibit significant low-frequency energy that corresponds to the wavelength of ripples. In contrast, the near-reef roughness spectra display an energy peak that corresponds to animal mounds (10-cm width). These results are consistent with independent observations that indicate greater biological activity near reef that has destroyed the ripples and replaced it with biogenic structures.

IMPACT/APPLICATIONS

The development of a photographic system capable of quantifying sea floor microtopography is likely to have widespread application in oceanography. For example, studies of sediment transport and acoustical interactions with the sea bottom would both benefit from knowledge of the short-term evolution of bottom roughness.

TRANSITIONS

None.

RELATED PROJECTS

The seafloor DEM data are being shared with E. Boss and R. Zaneveld to help in their study of roughness effects on bottom reflectance. In addition, the ADV data from the North Perry and closure sites were shared with Boss, Burdige and Voss for various purposes. Lastly, M. Allison and I are collaborating on the influence of near-surface porosity on light penetration.

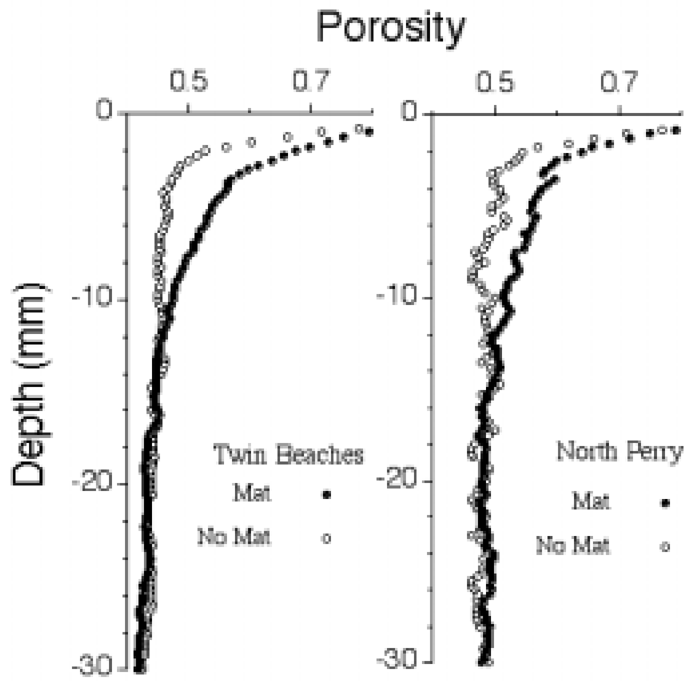

Figure 1. Average porosity in the upper 30 mm of the seabed for mat and no-mat seafloors at North Perry and Twin Beaches. The mat porosity is roughly 0.1 higher in the upper 10 mm.

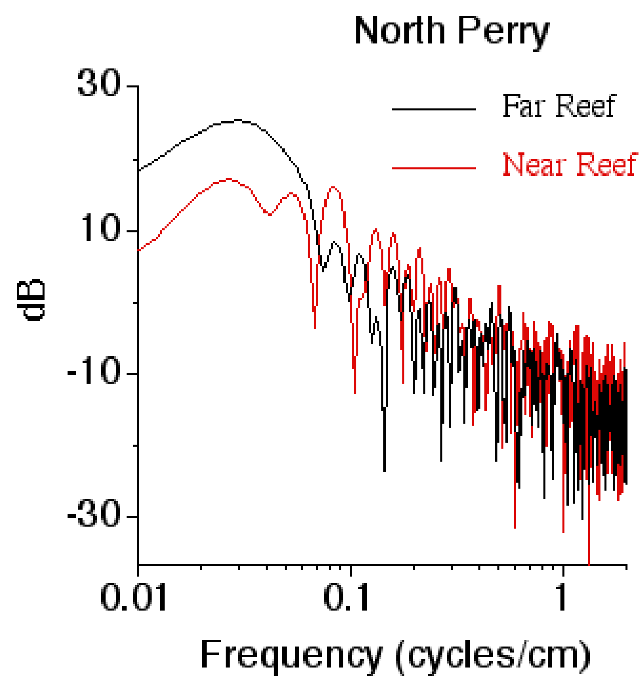

Figure 2. 1-D roughness power spectra for North Perry near-reef (red) and far -reef (black) digital elevation models.

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